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Clinical and radiological analysis of the causes for endodontic treatment failure

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SUMMARY

Introduction Development of inflammatory lesions or their persistence after primary treatment is considered endodontic failure. The reason for failure can be complex anatomy of the canal system and numerous iatrogenic factors.

The objective of this study was to analyze, clinically and radiographically, the causes of primary endodontic treatment failure and assess possibilities for retreatment of teeth with failed endodontic treatment.

Method The study included 79 teeth (36 multirooted and 43 singlerooted tooth) indicated for repeated endodontic treatment. Based on the radiographic assessment of the status of periapical structures, teeth were divided into two groups. The first group included teeth without periapical lesions, i.e. the healthy periodontal tissues (PAI score of 1 and 2) in which retreatment was required for prosthodontic reason due to the poor quality of obturation (28 teeth), and the second group included teeth with visible signs of periapical tissue damage (PAI scores 3, 4 and 5) (51 teeth). In both groups, quality of obturation, coronal sealing and the presence or absence of clinical symptoms was analyzed.

Results The most common radiographic finding of definitive obturation was short filling (65.8% of cases); "forgotten" canals (25.3%); non-homogeneous obturation with correct length (5.1%) and fractured instrument (3.8%). There was significant difference between healthy periodontal ligament and adequate restoration ($P < 0.001$). In 95% of patients with symptoms, changes in the periapical tissue were observed. Also, there was significant difference in the presence of symptoms after primary treatments, between the teeth with healthy apical periodontal tissue and teeth with periapical lesions ($P = 0.019$).

Conclusion The outcome of the root canal treatment is significantly affected by the quality (density) of obturation and the presence and quality of coronal restoration. In patients with symptoms there were changes in the periapical tissue.

Keywords: endodontic failure; obturation; coronal restoration; retreatment

INTRODUCTION

Healing of periapical lesions presented as reduction or disappearance of existing periapical radiolucency is expected after adequately conducted endodontic treatment. However, there are situations when bone repair is absent and there is no reduction in periapical radiolucency, often qualified as endodontic failure [1]. The success rate of endodontic treatment ranges from 53% - 97% [2-5]. Higher percentage indicates that almost every endodontic treatment is successful, while lower limit interval suggests that every other is unsuccessful.

Despite the undoubted frequency in everyday clinical practice, there is still no exact definition of endodontic treatment failure. Many clinicians came to the consent that lack of pain and other clinical symptoms or maintained function of endodontically treated teeth are important parameters of successful endodontic treatment [6]. The failure of endodontic treatment includes radiographic appearance of inflammatory lesions in the periapical tissue, which had not existed before or persistence of or enlargement of the radiolucency after undertaken primary treatment [6, 7].

The most common reasons for failure are: inadequate control of aseptic conditions [8-15], small access cavity (making difficult to locate all canals so some of them remain "forgotten"); inadequate instrumentation of the root canal, complications during endodontic treatment in the form of perforation of the root canal or separated instruments [16], inadequate obturation (short, non-homogeneous or overextended) [17-20] or microleakage of temporary or definitive coronal restoration [21, 22, 23].

Sometimes failure can occur even if endodontic treatment was properly managed and all procedures are fully respected. The reason for this is the complex anatomy of the canal system and numerous ramifications and anastomoses between the main and accessory canals that cannot be adequately treated or obturated using contemporary instruments, materials and techniques. Noninstrumented region of endodontic space can contain bacteria and necrotic tissue, even when not visible on the X-ray [12, 24].

There are factors outside the root canal, within the inflamed periapical tissue that could adversely affect post-operative healing of periapical lesions. Persistence of asymptomatic periapical radiolucency after thorough endodontic therapy can be caused by extra-radicular in-

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fection, true cysts, foreign bodies, the presence of cholesterol crystals or scar healing of the tissue [25].

The aim of this study was to analyze, clinically and radiographically, the causes of primary endodontic treatment failure and assess possibilities for retreatment of teeth with failed endodontic treatment.

METHOD

The study was conducted at the Clinic of Restorative Odontology and Endodontics, Faculty of Dental Medicine, University of Belgrade, Serbia. All participants signed consent to voluntary participation in the study after introducing with objectives and expected outcomes of the research.

67 patients of both genders, aged 24-79 years, and 79 teeth (36 multirrooted and 43 singlerooted tooth) indicated for repeated endodontic treatment were included in the study. One operator carried out clinical trial, while two researchers interpreted the assessment of radiographic outcome.

All 79 teeth had inadequate radiographic obturation and that was the key criterion in the assessment of the

failure of endodontic treatment. 52 teeth had short filling while 4 teeth had non-homogeneous filling. "Forgotten" canals were found in 20 teeth while 3 teeth had separated instruments (Table 1). In 36 teeth restoration was adequate or had valid prosthetic restorations, 5 teeth were without fillings a longer period of time, and 43 teeth had inadequate restoration.

Periapical status of each tooth prior to the re-treatment was assessed radiographically using PAI (periapical index) system as follows [26]:

- 1- PAI normal periapical structures
- 2- PAI small changes in bone structures that is not pathognomonic for apical periodontitis
- 3-PAI changes in bone structure with decalcification, characteristic for apical periodontitis
- 4-PAI periodontitis with clearly defined zone of radiolucency
- 5-PAI advanced periodontitis with signs of exacerbation and expansion of bone.

PAI score was determined for each tooth individually. X rays were analyzed on the light box using magnifying lens. Multirrooted teeth were evaluated according to the maximum damage of periodontal structures in any of the roots. Based on the state of periapical structures, teeth

Table 1. Distribution of teeth with endodontic failure in relation to the quality of obturation, coronal restoration and PAI index values.

Tabela 1. Distribucija zuba sa endodontskim neuspelom u odnosu na kvalitet opturacije i restauracije i vrednosti PAI indeksa

P A I	N	Quality of obturation Kvalitet opturacije				Quality of coronal restoration Kvalitet restauracije	
		Short filling Kratko punjenje	Nonhomogenous filling Nehomogeno punjenje	Separated instrument Zalomljen instrument	Missed canals Zaboravljeni kanal	Adequate Adekvatno	Inadequate Neadekvatno
1	14	10			4	12	2
2	14	10			4	9	5
3	29	16	3	1	9	9	20
4	15	11	1	2	1	3	12
5	7	5			2	3	4
Σ	79	52	4	3	20	36	43

Table 2. Distribution of teeth in relation to the presence of clinical symptoms in the group of teeth with healthy periapical tissue and the group with periapical lesions

Tabela 2. Distribucija zuba u odnosu na prisustvo kliničkih simptoma u grupi sa zdravim parodontalnim tkivima i grupi sa periapikalnim lezijama

Clinical symptoms Klinički simptomi		Teeth with healthy periapical tissue Zubi sa zdravim parodontacijom		Teeth with periapical lesions Zubi sa periapikalnim lezijama	
		N	%	N	%
Symptoms present Prisustvo simptoma	Yes Da	0	0,0	9	36%
	No Ne	15	100%	25	64%
Pain Bol	Yes Da	0	0,0	6	24%
	No Ne	15	100%	28	76%
Sensitivity to percussion Perkutorna osetljivost	Yes Da	0	0,0	3	12%
	No Ne	15	100%	31	88%
Swelling Otok	Yes Da	0	0,0	3	12%
	No Ne	15	100%	31	88%
Sinus tract Fistula	Da	0	0,0	3	12%
	Ne	15	100%	31	88%

were divided into two groups. The first group included teeth without periapical changes (PAI score 1 and 2) where retreatment was necessary for prosthetic reasons and poor quality of definitive obturation (28 teeth). The second group included teeth with visible signs of periapical tissue damage (PAI scores 3, 4 and 5) and included 51 teeth.

The second parameter in the analysis was the existence of clinical symptoms after the initial treatment. The first group included cases without clinical symptoms (diagnosed as incidental findings), and the second group included teeth with present clinical symptoms: pain, swelling, sensitivity to percussion, present sinus tract and others (Table 2).

RESULTS

Results are presented in Figures 1-4 and Tables 3-6.

Periodontal tissues were found healthy (PAI 1 and 2) in 35.4% of cases, while some changes in periapical tissue (PAI 3, 4 and 5) were recorded in 64.6% of cases. Short obturation was recorded in 65.8% of cases, while "forgotten" canals that were detected in 25.3% of teeth. Non-homogenous filling with correct length was noted in 5.1% of teeth and fractured instrument was found in the root canal of 3.8% of analyzed teeth (Table 3).

The quality of the coronal seal was inadequate in 54.5% of cases, while in 45.5% of cases coronal restorations had satisfactory quality (Table 4). Most of teeth with healthy



Figure 1. a) Maxillary first molar on the left with inadequate obturation (short, non-homogeneous and forgotten buccomesial canals); b) Final obturation after finished re-treatment; c) After 2 years- complete healing

Slika 1. a) Rendgenografski snimak prvog maksilarnog molara sa leve strane, sa neadekvatnom opturacijom (kratko, nehomogeno punjenje i „zaboravljeni“ bukozijalni kanali); b) Definitivna opturacija nakon retreatmana; c) Potpuno izlječenje posle dve godine

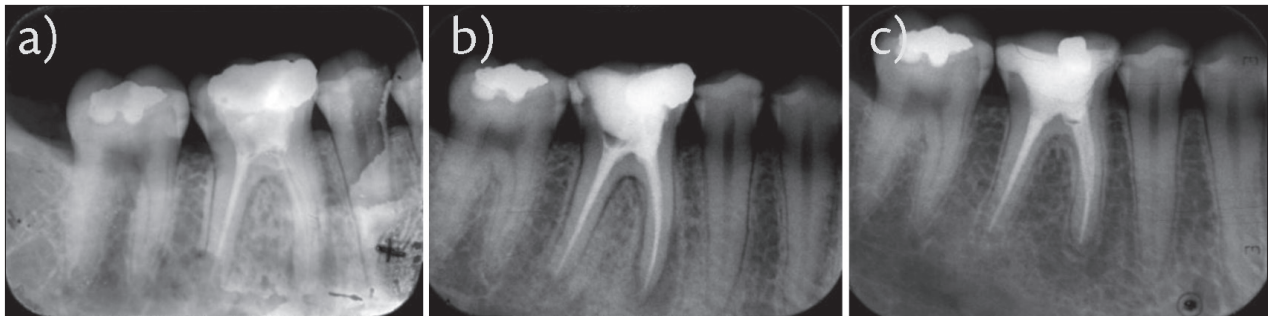


Figure 2. a) Mandibular first molar on the left with inadequate obturation and forgotten mesial canals. The tooth presented clinical symptoms of swelling and tenderness; b) Final obturation after finished re-treatment; c) Complete healing after 2 years

Slika 2. a) Rendgenografski snimak mandibularnog prvog molara sa leve strane (sa neadekvatnom opturacijom i sa „zaboravljenim“ mezijalnim kanalima). Zub je bio sa kliničkim simptomima otoka i bolne osetljivosti; b) Definitivna opturacija nakon retreatmana; c) Potpuno izlječenje posle dve godine

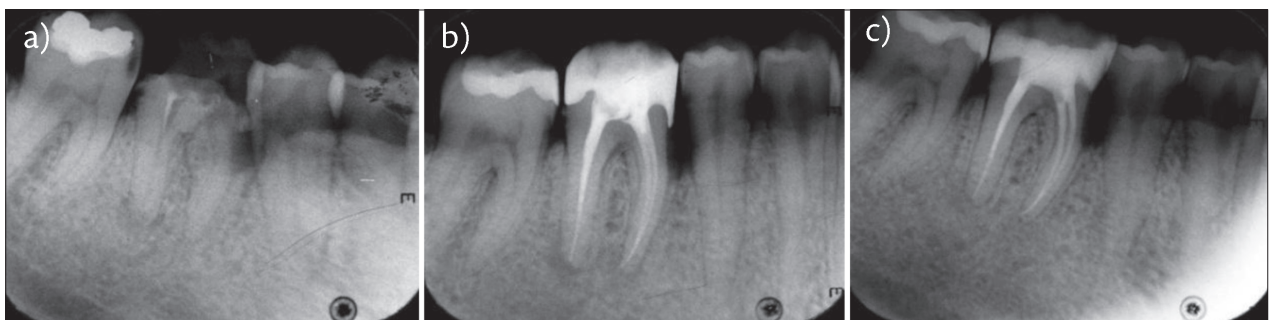


Figure 3. a) Mandibular first molar on the left side with short root canal filling in the distal canal and forgotten mesial canals; b) Final obturation after finished re-treatment; c) Complete healing after 2 years.

Slika 3. a) Rendgenografski snimak mandibularnog prvog molara sa leve strane sa kratkim punjenjem u distalnom kanalu i „zaboravljenim“ mezijalnim kanalima; b) Definitivna opturacija nakon retreatmana; c) Potpuno izlječenje posle dve godine

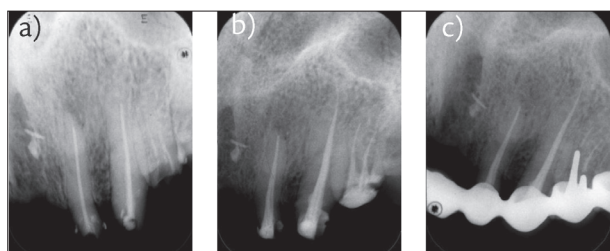


Figure 4. a) Failed endodontic treatment of maxillary lateral incisor, canine and first premolar on the right side. Periapical lesion is visible above the root of lateral incisor; b) Final obturation after finished re-treatment before prosthetic restoration; c) Complete healing after 2 years

Slika 4. a) Radiografski snimak neuspelog endodontskog lečenja na lateralnom sekutiću, očnjaku i prvom premolaru gornje vilice sa desne strane. Periapikalna lezija se uočava iznad korena lateralnog sekutića; b) Definitivna opturacija u okviru preprotetske pripreme pacijenta; c) Potpuno izlečenje nakon dve godine

periapical tissue (1, 2 PAI) were adequately restored (75%), while 70.6% of the teeth with apical periodontitis (PAI 3, 4, 5) had inadequate coronal restoration (Table 5).

χ^2 test showed high association between healthy periodontal tissue and adequate restoration on one side and micro leakage of inadequate restoration and periapical changes ($P < 0.001$) (Table 5)

In regards to the symptoms, 24% of patients had persistence of the symptoms after the initial endodontic therapy, while the remaining 76% of cases were asymptomatic. Out of all asymptomatic patients 95% had some changes in the

periapical tissue. Fisher's exact test showed association between the presence of symptoms after initial treatments and teeth with periapical lesions ($P = 0.019$) (Table 6).

DISCUSSION

This clinical study was conducted with the aim to analyze the outcomes and causes of the failure of primary endodontic treatments and to facilitate planning for clinicians how to perform retreatment. All cases were selected from everyday clinical practice at the Clinic of Restorative Odontology and Endodontics, School of Dental Medicine, University of Belgrade. A single therapist carried out retreatments.

Consent to participate in the study was signed by 37 patients of both genders, aged 24 to 79 years. Based on the clinical and radiographic examination they required repeated endodontic therapy. The study did not include patients with general diseases and those taking antibiotics in the last 3 months, and teeth with extensive decay destruction or poor periodontal status.

Primary endodontic treatment was done in 2 cases within a year, in 17 cases (34.7%) 1-5 years before the diagnosis of failure of previous treatment, while in 30 teeth (61%) primary endodontic treatment was done more than 5 years ago. Endodontically treated teeth have long survival rate in general. In fact, over 60% of root canal treated teeth are functional for more than 5 years. Salehrabi and

Table 3. Quality of obturation of the primary endodontic treatment in relation to the state of periapical tissue as measured by PAI Index
Tabela 3. Kvalitet opturacije primarnog endodontskog tretmana u odnosu na stanje apeksnog parodonticijuma merenog PAI indeksom

P A I	N	%	Quality of obturation Kvalitet opturacije							
			Short filling Kratko punjenje		Missed canals Zaboravljeni kanali		Nonhomogeneous filling Nehomogeno punjenje		Separated instrument Zalomljen instrument	
			N	%	N	%	N	%	N	%
1	14	17.7	10	12.6	4	5.1				
2	14	17.7	10	12.6	4	5.1				
3	29	36.7	16	20.2	9	11.4	3	3.8	1	1.3
4	15	18.9	11	13.9	1	1.3	1	1.3	2	2.5
5	7	8.9	5	6.3	2	2.5				
Σ	79	100	52	65.8	20	25.3	4	5.1	3	3.8

Table 4. Quality of coronal restoration in relation to the state of periapical tissue as measured by PAI Index.

Tabela 4. Kvalitet restauracije u odnosu na stanje apeksnog parodonticijuma izraženo PAI indeksom

P A I	N	%	Quality of coronal restoration Kvalitet restauracije			
			Adequate Adekvatna		Inadequate Neadekvatna	
			N	%	N	%
1	14	17.7	12	15.2	2	2.5
2	14	17.7	9	11.4	5	6.3
3	29	36.7	9	11.4	20	25.3
4	15	18.9	3	3.8	12	15.2
5	7	8.9	3	3.8	4	5.1
Σ	79	100	36	45.6	43	54.4

Rotstein (2004) carried out an extensive epidemiological study in the United States on 1,462,936 teeth. After 8 years, 97% of teeth were still present in the oral cavity [4]. On the other hand, other epidemiological studies [27, 28, 29] in the recent years indicated that over 30% of endodontically treated teeth were diagnosed with chronic periapical lesions (apical periodontitis) or according to Friedman- "post-treatment endodontic disease" [1].

From a total of 79 teeth, 35% of the teeth had no visible signs of periapical bone destruction, while in 65% of teeth the presence of chronic periapical lesions was registered. PCR analysis of the samples taken from the root canals of these teeth after removing old canal filling identified microorganisms in all teeth that had changes

Table 5. Quality of coronal restoration in relation to the periapical tissue health**Tabela 5.** Kvalitet restauracije u odnosu na stanje zdravlja apeksnog parodonticijuma

State of periapical tissue Stanje parodonticijuma	Adequate coronal restoration Adekvatna restauracija		Inadequate coronal restoration Neadekvatna restauracija		Total Ukupno	
	N	%	N	%	N	%
Healthy parodontium Zdrav parodonticijum PAI 1, 2	21	75%	7	25%	28	100
Periapical lesions Periapikalne lezije PAI 3, 4, 5	15	29.4%	36	70.6%	51	100
Σ	36	45.5%	43	54.5%	79	100

Table 6. Presence of symptoms after the initial root canal treatment in relation to the state of periapical tissue as measured by PAI index**Tabela 6.** Prisustvo simptoma nakon primarnog endodontskog lečenja u odnosu na stanje apeksnog parodonticijuma mereno PAI indeksom

State of periapical tissue Stanje parodonticijuma	Existence of symptoms Prisustvo simptoma		Without symptoms Odsustvo simptoma		Total Ukupno
	N	%	N	%	
Healthy parodontium Zdrav parodonticijum PAI 1, 2	1	1.3%	27	34.2%	28
Periapical lesions Periapikalne lezije PAI 3, 4, 5	18	22.8%	33	41.7%	51
Σ	19	24%	60	76%	79

in the periapical tissues. The most frequently identified microorganism, *E. faecalis*, was detected in 94% of the root canals with chronic periapical lesions.

Only 24% of patients had clinical symptoms such as pain, swelling, the existence of a sinus tract, or sensitivity to percussion and pain on biting. Most prevalent symptoms were sensitivity to percussion (59%) as a sign of chronic inflammation of the periapical tissue, and pain (47% of cases) as a sign of acute exacerbation of chronic periapical lesion.

All 79 tooth treated in our study had inadequate obturation. Most frequently registered was short filling in 65% of cases, "forgotten canals" (25%), clinically non-homogeneous filling (5.1%) and the presence of fractured instruments in 3.8% of canals. Whether inadequately obturated root canal is going to cause the failure of endodontic treatment depends primarily on the presence of bacteria in the root canal. If the vital pulp was treated and coronal restoration properly sealed, impermeable to bacteria, changes in the periradicular tissue will most likely not occur. However, if the canal was infected, an empty space in the apical part of the root will probably cause persistent intraradicular infection or maintain periradicular inflammation after completion of endodontic therapy [8–15].

In addition to the length of the apical canal filling, density ie. hermetic canal filling is an important factor for successful endodontic treatment. Unfortunately, micro computed tomographic studies have shown that even the most modern materials and techniques of instrumentation and obturation are not able to obturate root canal non-porously or to be impermeable to bacteria. Hammad i al. (2009) and Zogheib et al. (2013) measured the volume percentage of voids and trapped air in the apical third of the root canal obturated with Thermafil technique (gutta-percha and Topseal) and RealSeal technique (Resilion and RealSeal 1). After scanning and measurement of the volume of voids and unfilled space in obturated root canals, with respect to their total volume, they came to the con-

clusion that no technique of obturation provides absolute hermetic sealing of the endodontic space. Furthermore, the difference in the percentage of empty space between the novel adhesive endodontic materials and gutta-percha as gold standard was not statistically significant [30, 31].

It is obvious that the quality of obturation affects the outcome of endodontic treatment but this is not the only prerequisite for success. In our study all patients with inadequate obturation were referred to endodontic re-treatment, even though 17.7% of teeth did not have any changes in the periapical tissues (PAI 1), while at 17.7% of teeth there was slightly enlarged periodontal membrane (which is not pathognomonic finding of apical periodontitis) (PAI 2). In these cases, the retreatment was needed due to prosthetic reconstruction (intraradicular post). Such teeth were adequately restored in 75% of cases (21 out of 28 teeth) that provided good coronal seal, reduced microleakage and prevented (re) infection of the root canal and periapical tissues. Only one tooth with healthy periapical tissue did not have an adequate restoration and showed signs of acute infection (not visible changes on the x ray). Ray and Trope demonstrated that defective coronal restoration and adequate obturation have higher percentage of failures compared to the teeth with appropriate crown restoration and inadequate obturation [23]. Only 9% of teeth with adequate coronal filling and root canal obturation showed failure, in contrast to the teeth where obturation and coronal restoration were defective where the ratio was 82%. Gillen et al. (2011) conducted a systematic review of available literature about the effect of coronal restoration and root canal obturation and concluded that success of endodontic treatment would be higher if both, endodontic treatment and coronal restoration were done properly [21].

Out of all teeth with changes in the periapical tissue, 84% had inadequate restoration, and 50% of them had symptoms indicating the importance of good marginal seal. Similar findings were reported by Liang et al. (2011)

who used periapical radiography and CBCT to analyze factors required for successful endodontic treatment. Two years after pulpectomy, periapical radiography showed the presence of periapical lesions in 12.6%, while CBCT detected two times more chronic periapical changes (25.9%). Interestingly, 80% of root canal fillings radiographically determined as “short”, on CBCT were up to the apical terminus. They also concluded that density and apical extension of the root canal obturation significantly affected the outcome of endodontic treatment as judged by periapical radiographs. By analyzing data obtained by CBCT, for the success of the root canal treatment critical factors were density of the root canal filling and the quality of the coronal restoration [22].

Teeth with healthy periodontal tissue were sent to endodontic retreatment due to radiographically inadequate obturation (part of the preparation for prosthodontic rehabilitation) or were detected as incidental finding. Dilemma of whether teeth with inadequate obturation, healthy periapical tissue and without clinical signs and symptoms, should be retreated, is always current among endodontists. If tooth has already adequate restoration, it can be monitored by regular check-ups. However, if the tooth is planned to support fixed prosthodontic construction, with intraradicular post, retreatment is strongly recommended [32]. Success of repeated endodontic treatment relies on: proper diagnosis of the endodontic failure (periapical radiography, CBCT), adequate desobturation and repeated cleaning and shaping of the canal (the expertise of the therapist, instruments and materials), high-quality three-dimensional hermetic obturation of the root canal system, and timely and adhesive restoration placement after retreatment is finished.

CONCLUSION

The outcome of the root canal treatment is significantly affected by the quality (density) of root canal obturation and the presence and good quality of the coronal restoration. Most teeth with healthy periodontal tissue at the time of diagnosis of the failure of primary endodontic treatment were adequately restored. However, most teeth with changes in the periapical tissue had inadequate coronal restoration. Teeth in patients who had symptoms mostly had visible changes in the periapical tissue.

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Uzroci neuspeha endodontskog lečenja zuba

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KRATAK SADRŽAJ

Uvod Neuspehom endodontskog lečenja smatra se pojava radiografskog nalaza inflamatorne lezije, odnosno njeno perzistiranje ili uvećanje posle preduzete primarne endodontske terapije. Razlog za neuspeh mogu biti kompleksna anatomija kanalnog sistema, ali i brojni jatrogeni faktori.

Cilj ovog rada je bio da se kod zuba sa neuspelim endodontskim lečenjem klinički i radiografski analizira uzrok neuspeha primarnog endodontskog tretmana i procene mogućnosti za ponovni endodontski zahvat.

Metod rada U ovo istraživanje je uključeno 79 zuba (36 višekorenih i 43 jednokorena zuba) indikovanih za ponovljeni endodontski tretman. Na osnovu radiografske ocene stanja periapikalnih struktura zubi su podeljeni u dve grupe: prvu grupu su činili zubi bez periapikalnih promena, tj. sa zdravim parodontijumom (PAI skor 1 i 2) kod kojih je tretman bio neophodan iz protetskih razloga – zbog lošeg kvaliteta definitivne opturacije (28 zuba), a drugu zubi sa vidljivim znacima oštećenja apeksnog parodontijuma (PAI skor 3, 4 i 5) (51 zub). U obe grupe analiziran je kvalitet opturacije, kvalitet kruničnog zaptivanja i prisustvo ili odsustvo kliničkih simptoma.

Rezultati Najčešći radiografski nalazi kvaliteta definitivne opturacije kanala bili su: kratko punjenje (65,8% slučajeva), „zaboravljeni“ kanali (25,3%), klinički nehomogeno punjenje uz korektnu dužinu definitivnog punjenja (5,1%) i frakturiran instrument (3,8%). Nađena je statistički visoko značajna razlika između adekvatne restauracije i zdravog parodontijuma, odnosno pojave mikrocurenja zbog neadekvatne restauracije i periapikalnih promena ($p < 0,001$). Kod 95% pacijenata sa simptomima uočene su promene u apeksnom parodontijumu. Takođe, nađena je statistički značajna razlika u prisustvu simptoma nakon primarne endodontske terapije između zuba sa zdravim parodontijumom i zuba sa periapikalnim lezijama ($p = 0,019$)

Zaključak Na ishod endodontskog lečenja značajno utiču kvalitet (hermetičnost) opturacije kanala korena, odnosno prisustvo i kvalitet koronarne restauracije. Kod pacijenata sa simptomima uglavnom su postojale i promene u apeksnom parodontijumu nakon endodontskog lečenja.

Ključne reči: endodontski neuspeh; opturacija; restauracija

UVOD

Nakon adekvatno sprovedenog endodontskog tretmana očekuje se zarastanje, odnosno smanjenje ili iščezavanje postojećeg rasvetljenja iznad vrha korena na kontrolnim radiografijama. Međutim, postoje situacije kada koštana reparacija izostaje i ne dolazi do smanjenja periapikalnog rasvetljenja, pa se to često kvalifikuje kao endodontski neuspeh [1]. Stopa uspešnosti endodontske terapije kreće se od 53% do 97% [2–5]. Viši procenat ukazuje na to da je skoro svaki endodontski tretman uspešan, dok niža granica intervala sugerise da je svaki drugi neuspešan.

Uprkos nesumnjivoj učestalosti u svakodnevnoj kliničkoj praksi, među endodontistima još uvek ne postoji tačna definicija neuspeha endodontskog lečenja. Mnogi kliničari bi se složili da odsustvo bola i drugih kliničkih simptoma, odnosno očuvanost funkcije endodontski lečenog zuba, proglaše važnim parametrom uspeha endodontskog tretmana [6]. Neuspehom endodontskog lečenja se smatra postojanje radiografskog nalaza inflamatorne lezije u apeksnom parodontijumu koja ranije nije postojala, odnosno njeno perzistiranje ili uvećanje posle preduzete primarne endodontske terapije [6, 7].

Istraživanja ukazuju da su najčešći razlozi neuspeha: neadekvatna kontrola aseptičnih uslova rada [8–15], nedovoljno ekstenzivan pristupni kavitet (koji onemogućava pronalaznje svih kanala pa pojedini ostaju „zaboravljeni“ i neobrađeni), neadekvatna instrumentacija kanala, komplikacije tokom endodontskog tretmana u vidu perforacije korena ili frakture kanalnih instrumenata [16], neadekvatna opturacija kanalnog sistema (nedovoljna apikalna ekstenzija punjenja, nehomogeno punjenje ili preekstendirano kanalno punjenje) [17–20], odnosno mikrocurenje privremenih ili definitivnih koronarnih restauracija [21, 22, 23].

Ponekad se neuspeh može javiti i onda kada je endodontska terapija korektno vođena i sve procedure potpuno ispoštovane. Razlog za to je kompleksna anatomija kanalnog sistema i brojne ramifikacije i anastomoze između glavnog i akcesornih kanala koje se ne mogu adekvatno obraditi niti opturirati postojećim instrumentima, materijalima i tehnikama. Neinstrumentirane regije endodontskog prostora mogu sadržati bakterije i nekrotično tkivo čak i onda kada se čini da je opturacija kanala radiografski korektna [12, 24].

I na kraju, postoje ekstraradikalni faktori izvan kanala korena, u okviru inflamiranog periapikalnog tkiva koji mogu negativno uticati na postoperativno zarastanje periapikalnih lezija. Asimptomatsko perzistiranje radiografskog rasvetljenja iznad vrha korena nakon adekvatno sprovedene endodontske terapije mogu uzrokovati: ekstraradikalna infekcija, prave ciste, strana tela, prisustvo kristala holesterola ili ožiljno zarastanje tkiva [25].

Cilj ovog rada je bio da se kod zuba sa neuspelim endodontskim lečenjem klinički i radiografski analizira uzrok neuspeha primarnog endodontskog tretmana i procene mogućnosti za ponovni endodontski zahvat.

METOD RADA

Studija je sprovedena na Klinici za bolesti zuba i endodonciju Stomatološkog fakulteta Univerziteta u Beogradu. Nakon što su upoznati sa ciljevima i očekivanim ishodima istraživanja, svi učesnici su potpisali pristanak da dobrovoljno učestvuju u istraživanju.

U ovo istraživanje je uključeno 67 pacijenata oba pola starosti od 24 do 79 godina, odnosno 79 zuba (36 višekorenih i 43 jednokorena zuba) indikovanih za ponovljeni endodontski

tretman. Kliničko ispitivanje je sprovedeno od strane jednog operatera, dok su radiografsku procenu ishoda lečenja tumačila dva istraživača.

Svih 79 zuba imalo je radiografski nalaz neadekvatne opturacije jer je to bio ključni kriterijum u oceni neuspeha endodontskog lečenja. S obzirom na to da su sve opturacije bile nezadovoljavajućeg nivoa, njihov kvalitet je ocenjen kao kratko punjenje (52 zuba), nehomogeno punjenje (četiri zuba), prisustvo „zaboravljenih“ kanala (20 zuba) i zalomljeni instrumenti (tri zuba) (Tabela 1). Kod 36 zuba uočena je adekvatna restauracija ili validna protetska nadoknada, pet zuba je bilo bez ispuna duži vremenski period, a kod 43 zuba je uočena neadekvatna restauracija.

Periapikalni status svakog zuba pre početka tretmana procenjen je radiografski pomoću PAI (periapikalni indeks) sistema za skoriranje na sledeći način [26]:

PAI 1 – normalne periapikalne strukture

PAI 2 – male promene u strukturi kosti koje nisu patognomonične za apikalni periodontitis

PAI 3 – promene u koštanoj strukturi sa dekalifikacijom karakterističnom za apikalni periodontitis

PAI 4 – periodontitis sa jasno definisanom zonom rasvetljenja

PAI 5 – uznapredovao periodontitis sa znacima egzacerbacije i ekspanzije kosti.

PAI skor je određen za svaki zub pojedinačno, a radiografski nalaz je analiziran na negatoskopu uz primenu uveličavajuće lupe. Višekoreni zubi su ocenjivani u skladu sa najvećim oštećenjem parodontalnih struktura na jednom od korenova.

Na osnovu radiografske ocene stanja periapikalnih struktura zubi su podeljeni u dve grupe. U prvu grupu su svrstani zubi bez periapikalnih promena, tj. sa zdravim parodontijumom (PAI skor 1 i 2), kod kojih je tretman bio neophodan iz protetskih razloga – zbog lošeg kvaliteta definitivne opturacije (28 zuba). Drugu grupu, koja je obuhvatila 51 zub, činili su zubi sa vidljivim znacima oštećenja apeksnog parodontijuma (PAI skor 3, 4 i 5).

Drugi parametar u analizi bio je postojanje kliničkih simptoma nakon inicijalnog tretmana. Prvu grupu su činili slučajevi bez kliničkih simptoma (dijagnoza postavljena slučajnim nalazom), a drugu slučajevi sa kliničkim simptomima u vidu bola, otoka, perkutorne osetljivosti, odnosno postojanja fistule (Tabela 2).

REZULTATI

Dobijeni rezultati prikazani su u tabelama 3–6 i slikama 1–4.

Parodontalna tkiva su notirana kao zdrava (PAI 1 i 2) u 35,4% slučajeva, dok su destruktivne promene u periradikularnim parodontalnim tkivima (PAI 3, 4 i 5) zabeležene u 64,6% slučajeva.

Najčešći radiografski nalaz kvaliteta definitivne opturacije kanala zatečen u momentu dijagnostikovanja neuspeha endodontskog lečenja bio je kratko punjenje, koje je zabeleženo u 65,8% slučajeva, a zatim slede „zaboravljeni“ kanali, koji su detektovani u 25,3% zuba. Klinički nehomogeno punjenje uz korektnu dužinu definitivnog punjenja nađeno je kod 5,1% zuba, dok je u 3,8% slučajeva na radiografiji uočen frakturirani instrument u kanalu korena (Tabela 3).

Kvalitet krubičnog zaptivanja, odnosno restauracije zuba u momentu dijagnoze neuspeha endodontskog lečenja je u 54,5%

slučajeva bio neadekvatan, dok su u 45,5% slučajeva krubični ispuni bili zadovoljavajućeg kvaliteta (Tabela 4). Većina zuba sa zdravim parodontijumom (PAI 1, 2) bila je adekvatno restaurirana (75%), dok je 70,6% zuba sa obolelim apeksnim parodontijumom (PAI 3, 4, 5) imalo neadekvatne krubične restauracije (Tabela 4).

U grupi zuba sa zdravim parodontalnim tkivima 75% zuba je imalo adekvatnu koronarnu restauraciju, dok kod 25% krubično rubno zatvaranje nije bilo zadovoljavajućeg kvaliteta. Kod zuba sa hroničnim promenama u apeksnom parodontijumu 70,6% koronarnih restauracija u momentu dijagnostikovanja neuspeha endodontske terapije nije bilo adekvatno, dok je krubično zaptivanje bilo zadovoljavajuće u 29,4% zuba sa HAP-om (Tabela 5).

Analizom kvaliteta krubičnog zaptivanja i pojave promena u apeksnom parodontijumu, χ^2 testom dobijena je statistički visoko značajna razlika između adekvatne restauracije i zdravog parodontijuma, odnosno pojave mikrocurenja zbog neadekvatne restauracije i periapikalnih promena ($p < 0,001$) (Tabela 5).

Kada se sumiraju podaci o pojavi simptoma kod ovih pacijenata, 24% pacijenata je imalo neki od simptoma zabeleženih nakon inicijalne endodontske terapije, dok je preostalih 76% slučajeva bilo asimptomatsko. Među pacijentima koji su imali simptome 95% njih je iz grupe zuba sa promenama u apeksnom parodontijumu. Fišerovim testom tačne verovatnoće dobijena je statistički značajna razlika u prisustvu simptoma nakon primarne endodontske terapije između zuba sa zdravim parodontijumom i zuba sa periapikalnim lezijama ($p = 0,019$) (Tabela 6).

DISKUSIJA

Ova klinička studija je sprovedena sa ciljem da se analizira ju ishod i uzroci neuspeha primarne endodontske terapije i kliničarima olakša planiranje u slučaju neuspeha inicijalnog endodontskog lečenja. Svi tretirani slučajevi su izdvojeni iz svakodnevne kliničke prakse Klinike za bolesti zuba Stomatološkog fakulteta Univerziteta u Beogradu. Ponovni tretman je realizovan od strane jednog terapeuta.

Pristanak da učestvuje u istraživanju potpisalo je 37 pacijenata oba pola, starosti od 24 do 79 godina, kod kojih je pažljivim kliničkim i radiografskim pregledom indikovana ponovljena endodontska terapija. Svi pacijenti kod kojih je bilo potrebe za sanacijom neuspele inicijalne endodontske terapije su klinički i radiografski ispitani kako bi se postavila dijagnoza i indikacija za konvencionalni tretman. U istraživanje nisu uključeni pacijenti sa opštim oboljenjima i oni koji su uzimali antibiotiku terapiju u poslednja tri meseca, kao i zubi sa ekstenzivnim karijesnim destrukcijama ili lošim parodontalnim nalazom.

Primarna endodontska terapija je u dva slučaja sprovedena pre manje od godinu dana, u 17 slučajeva (34,7%) od jedne do pet godina pre dijagnoze neuspeha prethodnog lečenja, dok je kod 30 zuba (61%) primarno endodontsko lečenje urađeno pre više od pet godina. Sa aspekta opstanka zuba u usnoj duplji u funkciji vremena, primarna endodontska terapija se može smatrati dugoročno veoma uspešnom. Naime, preko 60% endodontski lečenih zuba opstalo je u stomatognatnom sistemu vršeći svoju ulogu u mastikaciji duže od pet godina. Salehrabi i Rotstein su 2004. godine sproveli obimnu epidemiološku studiju u Sjedinjenim državama na 1.462.936 zuba. Nakon osam godina 97% njih je još uvek bilo prisutno u usnoj duplji [4]. S druge

strane, druge epidemiološke studije poslednjih godina (*Boucher* i sar. 2002. godine u Francuskoj [27]; *Duglas* i sar. 2003. godine u Kanadi [28]; *Farzenah* i sar. 2004. godine u Torontu [29]) ukazuju da preko 30% endodontski tretiranih zuba pokazuje postojanje hronične periapikalne lezije (apikalnog periodontitisa) ili, po *Friedmanu*, „post-treatment endodontic disease“ [1].

Od ukupno 79 zuba, 35% zuba nije imalo vidljive znake destrukcije periapikalne kosti, dok je kod 65% zuba registrovano prisustvo hronične periapikalne lezije. PCR analizom uzoraka uzetih iz kanala korena ovih zuba identifikovani su mikroorganizmi u svim uzorcima iz zuba sa promenama u periapikalnim tkivima. Najčešće identifikovani mikroorganizam bio je *E. Faecalis*, detektovan u 94% kanala korena zuba sa hroničnim periapikalnim lezijama.

Ukoliko bi se kao kriterijum (ne)uspeha primarnog endodontskog tretmana uzela pojava kliničkih simptoma u vidu bola, otoka, postojanja fistule, perkutorne osetljivosti ili bolova na zagrižaj, onda bi to obuhvatilo svega 24% pacijenata. Najčešći simptomi su bili osetljivost na perkusiju (59% simptomatskih slučajeva), kao znak hroničnog zapaljenja periodontalnog ligamenta u apikalnoj regiji, i bol (47% slučajeva), kao znak akutne egzacerbacije hronične periapikalne lezije.

Kada je u pitanju kvalitet opturacije kao faktor uspeha endodontske terapije, kod 79 zuba obrađenih u ovom istraživanju registrovani su neadekvatna opturacija u vidu kratkog punjenja kod 65% zuba, „zaboravljeni kanali“ (25% kanala), klinički nehomogeno punjenje (5,1%) i prisustvo frakturiranog instrumenta (3,8% kanala). Da li nedovoljno napunjen kanal vodi u neuspeh endodontske terapije pre svega zavisi od dijagnoze, odnosno prisustva bakterija u kanalu korena. Ukoliko je endodontski tretman sproveden na vitalnoj pulpi, uz dobru koronarnu restauraciju, nepropusnu za bakterije, do promena u periradikularnim tkivima neće doći. Međutim, kada je u pitanju inficiran kanal korena, prazan prostor u apikalnom delu korena zuba podrazumeva perzistiranje intrakanalne infekcije, odnosno održavanje periradikularne inflamacije nakon završene endodontske terapije [8–15].

Osim apikalne ekstenzije kanalnog punjenja, važan faktor uspeha preduzete endodontske terapije je i gustina, tj. hermetičnost kanalnog punjenja. Nažalost, mikrokompjuterizovane tomografske studije su pokazale da ni najsavremeniji materijali i tehnike instrumentacije i opturacije nisu u mogućnosti da kanal neporozno, odnosno nepropusno za bakterije opturiraju. *Ham-mad* i sar. 2009. godine [30], a *Zogheib* i sar. 2013. godine merili su zapreminski procenat praznina i zarobljenog vazduha u apikalnoj trećini kanala korena opturiranih tehnikom Termafil (gutaperka i Topseal) i tehnikom opturacije RealSeal (Resilion i RealSeal 1). Nakon skeniranja i merenja zapremine praznina i zjapova u opturiranim kanalima u odnosu na njihovu ukupnu zapreminu došli su do zaključaka da nijedna tehnika opturacije ne omogućava apsolutno hermetičko zaptivanje endodontskog prostora, a da razlika u procentu praznih prostora između novih adhezivnih endodontskih materijala i zlatnog standarda gutaperke nije statistički značajna [31].

Očigledno je da kvalitet opturacije utiče na ishod endodontske terapije, ali da to nije jedini preduslov za uspeh. U ovom istraživanju svi pacijenti sa neadekvatnom opturacijom su upućeni na ponovni endodontski tretman, iako 17,7% (14 zuba) nije imalo promene u periapikalnim tkivima (PAI 1), dok je kod 17,7% (14 zuba) postojala neznatno proširena periodontalna membrana

(čiji nalaz nije patognomoničan za apikalni periodontitis) (PAI 2). U takvim slučajevima je retreatman bio uslovljen potrebom daljeg protetskog zbrinjavanja (kanalnom nadogradnjom) i protetskom nadoknadom, koji onemogućavaju konzervativni retreatman ukoliko se naknadno ukaže potreba za tim. Takvi zubi su bili adekvatno restaurisani u 75% slučajeva (21 od 28 zuba). Na taj način je postignuto dobro krunično zaptivanje, koje je maksimalno redukovalo mikrocurenje i na taj način preveniralo (re) infekciju kanala korena i periapikalnih tkiva. Samo jedan zub sa zdravim parodontijumom nije imao adekvatan ispun i pokazivao je znake akutne infekcije (koja se na radiografiji nije mogla uočiti). *Ray* i *Trope* [23] pokazali su da defektne restauracije i adekvatna kanalna punjenja imaju veći procenat neuspeha u odnosu na zube sa adekvatnim koronarnim restauracijama i neadekvatnim kanalnim punjenjima. Zubi kod kojih su i ispun i opturacija kanala bili adekvatni ukazali su na samo 9% neuspeha za razliku od zuba kod kojih su i punjenje i restauracija bili defektni, gde je taj procenat iznosio čak 82%. *Gillen* i sar. su 2011. godine sprovedli sistematski pregled dostupne literature na temu uticaja kvaliteta koronarne restauracije i kvaliteta kanalnog punjenja korena endodontski lečenih zuba i metaanalizom podataka došli do zaključka da izgledi za uspeh endodontske terapije rastu ukoliko su i endodontski tretman i krunična restauracija sprovedeni adekvatno, a da kvalitet opturacije kanala i krunične restauracije imaju jednak uticaj na izlečenje [21].

Među zubima sa promenama u apeksnom parodontijumu bilo je 84% neadekvatnih restauracija, od čega je 50% imalo izraženu simptomatologiju, što takođe ukazuje na značaj dobrog rubnog zatvaranja. Do sličnog zaključka su došli i *Liang*, *Wesselink* i sar., koji su 2011. godine sprovedli radiografsku studiju o preduslovima uspeha poredeći faktore koji se mogu registrovati retroalveolarnom radiografijom i CBCT-om. Na kontrolnom pregledu nakon dve godine od biopulpektomije, retroalveolarnom radiografijom je registrovana pojava periapikalnih lezija u 12,6%, dok je CBCT-om detektovano duplo više hroničnih periapikalnih promena (25,9%). Zanimljivo je da 80% punjenja koja su radiografski proglašena „kratkim“, na CBCT-u su bila do apeksnog terminusa. Zaključili su da gustina i apikalna ekstenzija punjenja na retroalveolarnim radiografijama značajno utiču na ishod endodontske terapije. Analizom podataka dobijenih CBCT-om, za uspeh endodontskog tretmana kao presudni faktori su označeni gustina kanalnog punjenja i kvalitet koronarne restauracije [22].

Grupa zuba sa zdravim parodontijumom obuhvatila je pacijente koji su poslani na ponovni endodontski tretman zbog radiografski neadekvatne opturacije (a u okviru preprotetske pripreme) ili je neuspeh otkriven slučajnim nalazom. Dilema da li zube sa neadekvatnom opturacijom a zdravim parodontijumom i bez kliničkih znakova i simptoma treba retreatirati uvek je aktuelna među endodontistima. Ukoliko zub neće biti deo protetskog rada, može se pratiti redovnim kontrolama, ali ukoliko se planira da zub bude nosač fiksne nadoknade sa intrakanalnom nadogradnjom, svakako treba pokušati „uraditi bolje“ [32]. Osnovni preduslovi za uspešnost endodontskog tretmana u ponovljenom zahvatu vezani su za pravilnu dijagnozu endodontskog neuspeha (Rtg, CBCT), adekvatnu dezoopturaciju i preparaciju u ponovnom čišćenju i oblikovanju kanala (stručnost terapeuta, instrumentarijum, materijali), odnosno kvalitetnu trodimenzionalnu hermetičnu opturaciju kanalskog sistema i kvalitetnu, pravovremenu i adhezivnu restauraciju endodontski lečenog zuba u ponovljenom tretmanu.

ZAKLJUČAK

Na ishod endodontskog lečenja značajno utiču kvalitet (hermetičnost) opturacije kanala korena, prisustvo i kvalitet koronarne restauracije. Većina zuba sa zdravim parodontcijumom, u momentu postavljanja dijagnoze neuspeha primarnog endo-

dontskog lečenja bila je adekvatno restaurirana, dok je većina zuba sa obolelim apeksnim parodontcijumom imala neadekvatne krunične restauracije. Kod pacijenata sa simptomima uglavnom su postojale promene u apeksnom parodontcijumu endodontski lečenih zuba.